

Permeability of MoDOT's Type 5 Base

Description:

The pavement structure is the most costly element of the highway system, and its premature failure is of major concern (Figure 1). Inadequate drainage has been identified as the most common cause of pavement failure (Figure 2). Prior to the current study, there was no quantitative evidence as to whether Missouri Department of Transportation's (MoDOT) Type 5 roadway base provided effective drainage beneath pavements.

Procedure:

The objective of this project was to characterize the hydraulic conductivity of the base materials used beneath pavements throughout Missouri. Materials included Type 5 base material from various sources and a rock fill alternate base material. The scope of the work performed included:

- Determination of grain size distribution of the base materials,
- Estimation of the hydraulic conductivity of the base materials using empirical equations,
- Determination of the hydraulic conductivity of Type 5 base material in the laboratory and in situ (Figures 3 and 4), and
- Determination of the drainage characteristics of the base material using pavement design software.

In addition, preliminary investigations of the strength of the Type 5 base under static and cyclic loading conditions were performed.



Figure 1 - Pavement Failure



Figure 2 - Inadequate Drainage



Figure 3 - Double Ring Infiltrometer Test

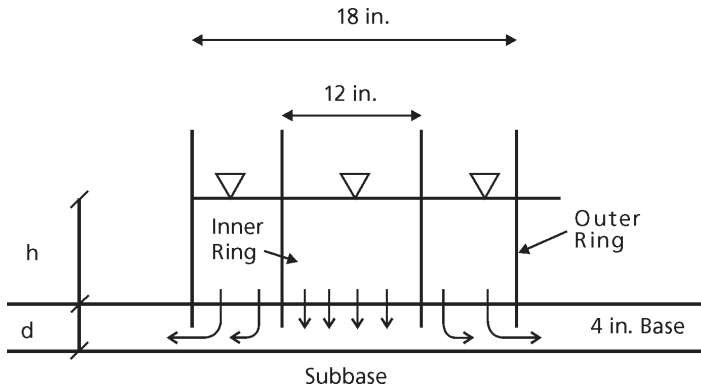
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Figure 4 - Schematic of Double Ring Infiltrometer Test

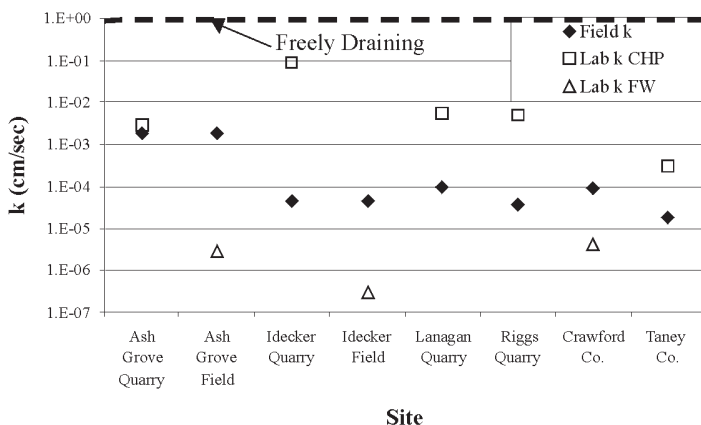


Results:

The results of field (in-situ) and laboratory permeability testing showed MoDOT's predominant pavement base "Type 5" (and the upper "working" surface of the 2-foot rock fill alternative) has hydraulic conductivities that are several orders of magnitude (10^{-3} to 10^{-5} cm/s) lower than the freely-draining value of 1 cm/sec Figure 5. In essence, these materials should be classified as undrained. Using the measured hydraulic conductivities in the FHWA's DRIP 2.0 analysis for evaluating pavement performance resulted in drainage quality rankings of poor to very poor based on the 1986 AASHTO Guide for Design of Pavement Structures. Given these findings, it is concluded that Missouri pavements might require more frequent maintenance if better drainage is not provided.

Preliminary strength testing was performed on the Type 5 base in order to quantify the strength behavior. Results of cyclic triaxial tests under saturated, undrained conditions performed on compacted, Type-5 base showed the saturated base loses strength with increasing number of load cycles. Drained cyclic tests resulted in the same behavior. The findings indicate that the Type 5 base does not allow moisture to escape (drain) sufficiently fast enough during traffic loading resulting in build up of excess porewater pressure and loss of strength in the layer.

Figure 5 - Permeability of Type 5 Base From Various Locations



Conclusions:

The field and laboratory permeability testing showed the Type 5 base to have such low hydraulic conductivities as to be considered undrainable. Preliminary cyclic strength tests showed the base loses strength with increasing number of load cycles. This behavior could explain the premature deterioration of some pavements in Missouri. Providing adequately drainable bases will increase the effective performance life, reduce maintenance frequency and reduce replacement costs for Missouri pavements.

Recommendations:

It is recommended that a more durable roadway base be developed. One that provides an adequate working platform during construction and good drainage for extended lifetimes. Several tasks are recommended in order to gather high quality data (evidence) that is prerequisite for the development of an effective specification for roadway base in Missouri. A program of laboratory strength testing, in situ permeability testing instrumented pavement sections and a geographical information system-based pavement performance database should be undertaken. Such a program will provide the necessary evidence on which to initiate changes to Missouri's pavement base system which will provide higher performance, longer-lasting and more economical pavement systems.

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